

# 辽宁黑山恐龙蛋——长形蛋类新分子的发现及其意义<sup>1)</sup>

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**摘要** 辽宁西部黑山县下白垩统发现我国最早的恐龙蛋壳化石,属长形蛋类,取名常氏黑山蛋(新属新种)(*Heishanoolithus changii* oogen. et oosp. nov.)。该新属种蛋壳表面具密集的细瘤状纹饰,局部相邻的两个或数个细瘤联结成链条状细脊,锥体层极薄,锥体层与柱状层之比约为1:7。根据埋藏情况来看,产蛋恐龙生活在湿热、植被茂盛的河湖沼泽附近的生态环境。

**关键词** 辽宁黑山,下白垩统,沙海组,恐龙蛋壳

**中图法分类号** Q915.21

辽宁西部 90 年代以来以原始鸟类、原始哺乳类和爬行类及两栖类化石的发现为古生

物学者所密切关注。1994 年,中国科学院古脊椎动物与古人类研究所胡耀明、王元青与原东北煤炭总公司常征路先生到该地区考察,在黑山县八道壕镇地方煤矿发现了一些恐龙蛋壳碎片,这是我国早白垩世早—中期恐龙蛋的首次发现,也是我国迄今为止发现的最早的恐龙蛋蛋片。

辽宁省黑山县晚中生代地层由老到新由义县组、九佛堂组、沙海组、阜新组、孙家湾组组成。蛋壳化石产于沙海组。沙海组按岩性可分为两部分:下部为主要含煤段,厚 105m,以灰、灰白、灰黑色砂质泥岩和泥岩为主,含煤 4 层,属冲积扇、小型河流、浅湖及沼泽相,恐龙蛋壳化石产自该含煤段可采煤层的煤层夹矸中,其夹矸岩性为含碳质极高的碳质页岩;上部

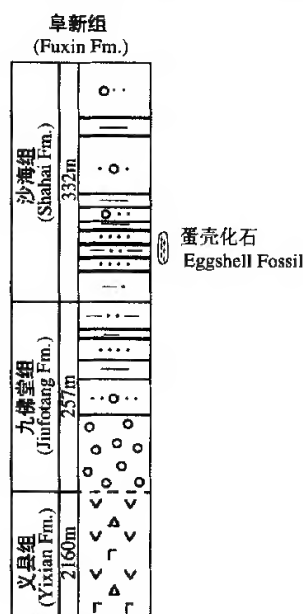


图1 恐龙蛋壳化石产出层位(根据许坤等,1998编绘)

Fig.1 The position of the eggshells in the stratigraphic section of Heishan (Adapted from Xu *et al.*, 1998)

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以灰、灰白色砾岩及砂砾岩为主,夹薄煤层或煤线,顶部逐渐过渡为赤褐色砂砾岩层,厚 227m,产双壳类、腹足类、介形类、植物、恐龙牙齿等化石(许坤等,1998);时代属早白垩世早—中期,可能相当于凡兰吟期(Valanginian)或欧特里沃期(Hauterivian)(Wang *et al.*, 1995)。

### 长形蛋科 Elongatoolithidae Zhao 1975

#### 黑山蛋属(新属) *Heishanoolithus* oogen. nov.

**属名** Heishan—化石产地所在县的汉语拼音。

**属征** 见“种征”。

#### 常氏黑山蛋(新属新种) *Heishanoolithus changii* oogen. et oosp. nov.

(图版 I, 1~4)

**词源** changii 种名赠给为辽西地层古生物学研究作出贡献的常征路先生。

**种征** 壳薄,外表面纹饰呈密集的细瘤状,局部相邻的两个或数个细瘤联结成链条状细脊,所有纹饰延伸方向彼此一致;壳厚 1.2~1.3mm 左右;锥体层薄,与柱状层之比约为 1:7。

**正型标本** 化石蛋片 7 片;IVPP V 11578。

**产地和层位** 辽宁黑山八道壕;下白垩统沙海组。

**描述** 蛋壳保存在煤层夹研中,4 层蛋壳重叠在一起,部分蛋壳脱落或经取样后,仍可见蛋壳外表面纹饰留下的印痕(图版 I, 1);根据保存情况推断,保存的蛋片位置相当于蛋的中部。

蛋壳呈灰色,薄,平均厚 1.3mm(不含纹饰高度);蛋壳外表面具纹饰,纹饰呈密集的细瘤状,每平方毫米 3~4 个,相邻的两个或数个细瘤可联结成链条状细脊(图版 I, 2),纹饰突起高度 0.18~0.27mm,细瘤长平均 0.8mm,宽平均 0.3mm,细脊长 1.5mm;所有纹饰延伸方向基本一致。

**组织结构特征** 锥体层厚 0.15mm,约占蛋壳厚度的 1/8,锥体排列较密,每毫米具 5~6 个锥体,单个锥体圆锥状,楔体放射状,内部结构不清(图版 I, 4),锥体色泽较深,锥间隙不大,锥体在靠近内表面的弦切面呈不规则多边形;柱状层厚 1.1mm,在靠近锥体层处,由大小不同的块状方解石晶体组成,结构紊乱,生长纹仅依稀可见,可能为次生矿化作用所致;渐向外柱状层呈密集的层状,愈向外层状愈明显,楔状放射线也清晰可辨,生长纹十分发育,起伏与外表面一致(图版 I, 3);正交镜下,消光发生在壳的中上部,纹饰下呈现楔状消光,壳平滑处呈现柱状消光。

**鉴定** 本文描述的标本以蛋壳表面纹饰及似鸟蛋型组织结构特征而归入长形蛋科。

**比较与讨论** 长形蛋科为赵资奎(1975)所建立,其科鉴别特征为:蛋化石长形,一端钝另一端略尖,其长径和横径之比大约为 2:1,蛋壳表面具有瘤状小突和链条状细脊,蛋在蛋窝中排列十分规则——两个相互并列的蛋为一组,每组之间以 40°~50°相隔,并作椭圆形放射状排列,可以重叠 3 层或 4 层;蛋壳的径切面呈似鸟蛋型组织结构特征,气孔道窄而

直(赵资奎, 1975; Zhao, 1993)。

长形蛋科现正式定名的计有五属, 它们是: 巨形蛋属 *Macroolithus* Zhao, 1975, 长形蛋属 *Elongatoolithus* Zhao, 1975, 南雄蛋属 *Nanhsiungoolithus* Zhao, 1975, *Trachoolithus* Mikhailov, 1994, *Ellipsoolithus* Mohabey, 1998。巨形蛋属的蛋化石较大, 蛋壳外表面具有粗糙的瘤状小突和链条状的棱纹纹饰, 锥体层和层状柱状层之间有明显的分界; 长形蛋属蛋壳较薄, 外表面呈细脊状纹饰, 纹饰比巨形蛋属细长, 突起程度也较弱, 锥体层和柱状层之间没有明显分界; 南雄蛋属的蛋较小, 蛋壳外表面的链条状纹饰很不明显, 一般比较光滑, 生长纹略呈波浪形, 柱体之间彼此界线分明; *Ellipsoolithus* 纹饰呈细弱弯曲的脊状纹饰, 锥体层与柱状层有不甚明显的界线。

相比之下, 产于蒙古下白垩统 Dushi Ula 组, 相当于纽康姆阶顶 (Uppermost Neocomian) 至阿普特阶 (Aptian) 之间的 *Trachoolithus* 与本文研究的标本较为近似。然而, *Trachoolithus* 的蛋壳极薄, 厚仅为 0.3~0.5mm, 但纹饰突起极其显著, 加上纹饰厚度也已达 0.9mm, 纹饰突起高度可达壳厚度的 2/3; 而本文描述的标本蛋壳外表面纹饰呈密集细瘤状 (3~4 个/mm<sup>2</sup>), 细瘤略纵向拉长, 少量细瘤联合形成链条状细脊, 所有纹饰延伸均沿长径方向, 锥体层与柱状层之比约为 1:7, 两者有明显的不同, 故黑山标本应代表长形蛋科的一新类型, 我们将其命名为长形蛋科的一新属——黑山蛋属, 其模式种取名为常氏黑山蛋。

长形蛋类化石在中国分布很广, 如广东南雄盆地、山东莱阳盆地、河南淅川盆地等, 是晚白垩世恐龙蛋的常见分子(赵资奎, 1975; Zhao and Jiang, 1974; 赵宏、赵资奎, 1998), 河南西峡盆地也有发现, 但研究程度不够, 时代可能为早白垩世(?) (Zhao, 1994; 李酉兴等, 1995); 此外, 在亚洲其他地区, 印度发现于 Kheda, 时代为晚白垩世末 (Mohabey, 1998); 蒙古及哈萨克斯坦, 时代为早白垩世—晚白垩世 (Mikhailov, 1991)。

在北美, 发现于犹他州的部分恐龙蛋应属长形蛋类 (*Elongatoolithidae*), 时代为早白垩世至晚白垩世。赵资奎 (1975) 将 Jensen (1970) 定名的 *Oolithes carlyensis* 建议改名为 *Macroolithus carlyensis*, 并认为 Jepsen (1931)、Jensen (1966) 描述的部分标本应属长形蛋属。

北美发现于蒙大拿上白垩统吐·迈迪逊组 (Two Medicine Formation) (Hirsch and Quinn, 1990) 及新墨西哥州上侏罗统莫里孙组 (Morrison Formation) (Bray and Lucas, 1997) 的似鸟蛋型结构类型的恐龙蛋也应属长形蛋类 (科), 但它们都不能属于长形蛋属, 也不能归于目前笔者描述的属。因为前两者蛋壳表面纹饰均呈小的瘤状, 偶或数个细瘤联合成细脊, 但小瘤都较圆, 没有明显的方向; 而长形蛋属蛋壳外表面呈细脊状纹饰, 本文描述的黑山蛋属蛋壳纹饰呈密集细瘤状, 细瘤略纵向拉长, 局部两个或数个细瘤联合成链条状脊, 且所有纹饰保持一致的方向性。Bray 等 (1997) 认为北美的似鸟蛋型结构类型蛋壳表面的纹饰呈分离的瘤 (nodose sculpturing, dispersituberculate), 而亚洲的则呈链条状纹饰 (lineartuberculate)。从目前来看似乎确实存在这种现象, 北美的长形蛋类标本瘤饰很圆, 而亚洲即使发现有瘤状纹饰, 也多少呈纵向拉长状 (如本文描述的标本)。

鉴于同一枚蛋中蛋壳外表面的纹饰从蛋的中部向两端可能发生一定的变化, 所以不同蛋壳之间蛋壳纹饰的比较应尽量避开蛋的两端部位, 同时采用同一部位纹饰特征进行

比较。辽宁黑山恐龙蛋化石的蛋壳碎片,可以确定位于蛋的中部,我们将其与其他种类恐龙蛋进行了同一部位的比较,因而我们的比较结论是可靠的。

辽宁黑山恐龙蛋是我国早白垩世早—中期恐龙蛋的最可靠发现,同时代表着中国迄今为止发现的时代最早的恐龙蛋化石。从常氏黑山蛋蛋壳碎片的保存来看,约4层蛋壳叠置在一起,由于蛋片仅4cm×2cm见方,故蛋及蛋窝的确切形态不可能正确推断,但仍可判断出:蛋呈长形,蛋的纹饰走向与长径一致。由于蛋壳薄而蛋壳表面纹饰保存完好,故我们推断其沉积过程系非异地搬运的埋藏状态;其产出围岩为含碳质极高的煤层夹矸,可以进一步推断常氏黑山蛋的产蛋恐龙生活在较为湿热、植被茂盛的生态环境。

目前长形蛋结构类型已有确切的恐龙胚胎发现,因而长形蛋的结构类型与恐龙的分类关系可以确定。Norell等(1994)在恐龙蛋中发现恐龙胚胎,其胚胎经鉴定为窃蛋龙,其蛋为长形蛋结构类型,时代为晚白垩世,目前人们据此通常认为长形蛋结构类型的恐龙蛋一般为兽脚类恐龙所产。

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## A NEW FORM OF ELONGATOOLITHID DINOSAUR EGGS FROM THE LOWER CRETACEOUS SHAHAI FORMATION OF HEISHAN, LIAONING PROVINCE

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**Key words** Heishan, Lower Cretaceous, dinosaur eggshell

### Summary

Since 1990's, considerable amounts of fossil birds, reptiles, mammals and amphibians discovered in the western territory of Liaoning Province have been paid great attention. In 1994, some eggshells of dinosaur eggs were found in the Lower Cretaceous Shahai Formation in Heishan County, Liaoning Province.

The strata of Late Mesozoic, in the fossil locality, consist of Yixian Formation, Jiufotang Formation, Shahai Formation and Sunjiawan Formation in ascending order.

The 332m thick Shahai Formation may be subdivided into two members. The lower member is composed of 4 layers of coal seams with grayish, grayish white, grayish black mudstone. The lithostratigraphic facies are alluvial, small-scale fluvial, shallow lacustrine and swamp. The dinosaur eggshells are born of the gangue in main coal seam. Upper member of Shahai Formation consists of gray, grayish white

conglomerate and sand conglomerate intercalated with four thin coal seams and some coal lines. Various kinds of fossils, including Bivalves, Gastropod, Ostracod, Plant, dinosaur teeth have been also found in this formation.

### **Elongatoolithidae Zhao, 1975**

#### ***Heishanoolithus* oogen. nov.**

**Etymology** heishan-, in reference to the county name of the fossil locality.

**Diagnosis** See the diagnosis of *Heishanoolithus changii* oogen. et oosp. nov.

#### ***Heishanoolithus changii* oogen. et oosp. nov.**

(pl. I, 1~4)

**Etymology** changii- is named after Mr. Chang Zhenglu, who contributes a lot to the study of stratigraphy and paleontology in western Liaoning.

**Holotype** 7 pieces of eggshells; IVPP V 11578.

**Locality and horizon** Badaohao, Heishan County, Liaoning Province; Lower Cretaceous, Shaihai Formation.

**Diagnosis** Eggshell thin, about 1.2~1.3mm. Ornament character of outer surface densely nodes-like. Two or several adjacent slender-nodes coalescing into chain-like (lineartuberculate) ridges. Ornamentation approximately oriented along the longitudinal axis. Cone layer thin. Ratio of cone layer to column layer nearly 1:7.

**Description** The eggshells are preserved in the gangue, with about 4 layers of eggshells overlapping together. Peeled off or sampled, some ornament imprints of outer surface are observable (pl. I, 1).

The eggshell is thin with gray color. The average thickness is 1.3mm (not including the height of ornament). The outer surface is sculptured with densely slender-nodes, 3~4 per mm<sup>2</sup>. Sometimes, two or several slender-nodes are connected by lower ridges (pl. I, 2). The sculpture is 0.18~0.27mm in height, slender-nodes 0.8mm in length and 0.3mm in width, and the slender ridge is 1.5mm long. The ornamentation is approximately oriented along the longitudinal axis.

The thickness of cone layer is 0.15mm, about one eighth of eggshell. Cones are lined collectively with 5~6 per mm. The cunei of each cone seem to be radiant-like with inner structure unclear (pl. I, 4). The thickness of columnar layer is about 1.1mm. Near the cone, it displays variant sizes of blocky calcite, the structure disorder and growth lines ambiguous maybe because of secondary mineralization.

The undulating growth lines in the columnar layer become developed toward outer surface (pl. I, 3). Under the polarized light, the extinction position is above the middle-upper part of the eggshell in radial section, with column extinction pattern below the nodes and the cuneiform extinction below the interspaces between the nodes.

**Comparison and discussion** The diagnosis of our specimens found in Heishan is summarized as follows: Eggshell thickness 1.2~1.3mm. Cone layer thin, 1/8 of eggshell thickness. Columnar layer with undulating growth lines. Outer surface is sculptured with nodes of medium height and a few low ridges. The eggshell specimens studied belong to the Elongatoolithidae, and the characteristics of the eggshells seem to be close to that of *Trachoolithus* found in the Lower Cretaceous Dushi Ula Formation of Mongolia (Mikhailov, 1994). However, there are still some differences between them. The eggshell of *Trachoolithus* is extremely thin (0.3~0.9mm). Outer surface is sculptured with nodes up to 2/3 of eggshell thickness. Therefore, our specimen is considered to be a new oogenus and oospecies of the Elongatoolithidae, and assigned the name *Heishanoolithus changii*.

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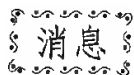
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### 图版说明(Explanations of Plate I)

常氏黑山蛋(新属新种) (*Heishanoolithus changii* oogen. et oosp. nov.) IVPP V 11578

1. 示蛋壳保存及表面纹饰情况 signifying the preserved condition and its outer ornaments of the eggshells
2. 示蛋壳表面纹饰(电镜下) showing the ornamentation on the outer surface of eggshell, SEM
3. 蛋壳径切面示内部组织结构(电镜下) radial view; showing the histostructure of the eggshells, SEM
4. 蛋壳径切面示锥体形态(电镜下) radial view; showing the form of cones, SEM

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## 我国学者在兽脚类恐龙研究方面取得重要进展

1999年9月16日的英国《自然》杂志刊登了我国青年学者徐星、汪筱林和吴肖春在兽脚类恐龙研究方面取得的最新成果。中国科学院古脊椎动物与古人类研究所辽西课题组在1998年度的野外工作中,从辽西义县组下部页岩中采集到一批珍贵的脊椎动物化石,其中包括一块保存有皮肤衍生物的兽脚类恐龙化石标本。这件标本代表兽脚亚目驰龙科的一个新属种,被命名为中国鸟龙(*Sinornithosaurus*)。中国鸟龙和另外四种保存有皮肤衍生物的兽脚类恐龙,即中华龙鸟、原始祖鸟、尾羽鸟和北票龙一样,都产自我国著名的中生代化石产地——辽宁省北票市上园镇炒米甸子村四合屯附近。这样,迄今为止,在辽西义县组下部已经发现了五种长有绒羽状或者体羽状结构的非鸟兽脚类恐龙。

中国鸟龙的发现对于驰龙类形态研究具有重要意义。传统上,鸟类恐龙起源假说的兴起始于对驰龙的研究。然而,由于材料的局限性,过去对于驰龙类解剖结构实际上存在着很多误解。中国鸟龙的发现为详细研究这一门类恐龙的解剖结构提供了可能,初步的研究表明驰龙类在形态上已经非常接近早期鸟类。以中国鸟龙为代表的驰龙类的头后骨骼具有许多早期鸟类的特征,它的肩带结构和始祖鸟几乎没有区别,在形态结构上已经完全具备了拍打式飞行的要求,是一种典型的预进化模式。系统分析研究表明,驰龙类代表与鸟类亲缘关系最为接近的一类非鸟兽脚类恐龙。这一观点不同于另外一种观点:即伤齿龙类与鸟类的关系最为接近。中国鸟龙的另外一个重要意义在于第一次为驰龙科恐龙发育细丝状皮肤衍生物提供了证据,表明这种构造在非鸟兽脚类恐龙中分布较为广泛。

辽西地区义县组下部非鸟兽脚类恐龙化石的发现为鸟类起源、羽毛起源和飞行起源等重要问题的研究提供了大量信息。已知的证据强烈支持鸟类兽脚类恐龙起源说,同时表明,作为鸟类独有特征的羽毛的分布范围实际上并不局限在鸟类当中,某些兽脚类恐龙已经发育有羽毛状结构,羽毛的发育早于鸟类的起源。中国鸟龙的发现还表明,涉及鸟类飞行的一些形态结构上的变化实际上在非鸟兽脚类恐龙当中已经完成。

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